

WHAT IS CLAIMED IS:

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1. A device for performing sound field hearing testing, said device comprising:

a) an audio transducer for producing acoustic test stimuli to a test subject within the direct sound field range of said audio transducer, and

b) a contactless position sensor system for measuring the position of said device with respect to the head or part thereof of interest of said test subject,

whereby hearing evaluation of said test subject, when properly positioned relative to said device, may be performed by said device based on said acoustic test stimuli.

2. The device of claim 1, including means for automatically determining or adjusting characteristics of said acoustic test stimuli, including onset, amplitude and frequency characteristics, in response to position measurements performed by said position sensor system.

3. The device of claim 1, wherein said device is constructed and adapted to be hand held by said test subject.

4. The device of claim 1, wherein said device is configured as a wrist watch.

5. The device of claim 1, wherein said device is configured for operation by a test operator assisting said test subject.

1 6. The device of claim 1, including means for performing said hearing evaluation  
2 in an unaided condition in which said test subject is not wearing a hearing aid.

1           7.     The device of claim 1, including means for performing said hearing evaluation  
2     in an aided condition in which said test subject is wearing a hearing aid.

1           8.     The device of claim 7, including means for performing said hearing evaluation  
2     in said aided condition to verify functionality of said hearing aid worn by said test subject.

1           9.       The device of claim 7, including means for performing said hearing evaluation  
2       in said aided condition to adjust at least one parameter of said hearing aid.

1           10.    The device of claim 1, further comprising means for delivering at least one of  
2    said acoustic test stimuli within the soft level listening range of normal hearing individuals.

1            11.    The device of claim 10, wherein said soft level listening range is between 20 and  
2            40 dB HL.

1           12.    The device of claim 1, further comprising means for delivering at least one of  
2    said acoustic test stimuli within the comfortable level listening range of normal hearing

3 individuals.

1 13. The device of claim 12, wherein said comfortable level listening range is  
2 between 45 and 65 dB HL.

1 14. The device of claim 1, wherein said contactless position sensor system  
2 comprises at least one of an optical transducer, acoustic transducer and ultrasonic transducer.

1 15. The device of claim 1, wherein said contactless position sensor system  
2 comprises means for automatically computing the distance between said device and the head  
3 or part thereof of interest of said test subject.

1 16. The device of claim 1, wherein said contactless position sensor system  
2 comprises means for automatically determining if the device is within an operable range and  
3 orientation with respect to the head or part thereof of interest of said test subject.

1 17. The device of claim 1, wherein said contactless position sensor system  
2 comprises a transmitting transducer and a receiving transducer.

1 18. The device of claim 17, wherein said contactless position sensor system  
2 comprises means for computing the distance between the device and the head or said part

3 thereof of interest of said test subject based on the latency period between a transmitted signal  
4 emitted by said transmitting transducer and reflected signal received by said receiving  
5 transducer.

1 19. The device of claim 17, wherein said transmitting transducer and receiving  
2 transducer are combined in a unitary bidirectional transducer.

1 20. The device of claim 1, further comprising means to select from at least two  
2 types of acoustic test stimuli including speech, noise and tone types.

1 21. The device of claim 1, further comprising means to select acoustic test stimuli  
2 in at least two frequency ranges.

1 22. The device of claim 1, further comprising at least one switch for selection of at  
2 least one acoustic test stimulus.

1 23. The device of claim 1, further comprising interface means for connecting a  
2 remote instrument to said device for remotely operating said device.

1 24. The device of claim 23, wherein said remote instrument comprises a computer.

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1           **25.**   The device of claim **23**, wherein said interface means comprise an electrical  
2   cable.

1           **26.**   The device of claim **23**, wherein said interface means comprise the Internet.

1           **27.**   The device of claim **23**, wherein said interface means comprise a wireless link  
2   including any of infrared, radio frequency, electromagnetic, sound, or ultrasound.

1           **28.**   The device of claim **23**, further comprising response registration means for  
2   registering test responses by said test subject and relaying said test responses to said remote  
3   instrument.

1           **29.**   The device of claim **28**, wherein said response registration means comprise at  
2   least one key.

1           **30.**   The device of claim **1**, further comprising visual status display means, including  
2   liquid crystal display (LCD) and light emitting diode (LED).

1           **31.**   The device of claim **1**, further comprising a controller.

1           **32.**   The device of claim **1**, further comprising memory for storage of data

2 representative of acoustic test stimuli.

1 33. The device of claim 1, further comprising a microphone.

1 34. The device of claim 33, wherein said microphone provides means for measuring  
2 ambient background noise, for self testing, or for self calibration of said device.

1 35. The device of claim 7, further comprising wireless remote control means for  
2 controlling or adjusting at least one parameter of said hearing aid worn by said test subject.

1 36. The device of claim 35, wherein said wireless remote control means comprise  
2 a magnet.

1 37. A hand held device for performing sound field hearing evaluation in a  
2 contactless manner with respect to a test ear of a test subject, said device comprising:

3 a) an audio transducer for delivering acoustic test stimuli to said test subject  
4 holding said device within the direct sound field range of said audio transducer,

5 b) means for selecting delivery of said acoustic test stimuli through said audio  
6 transducer at two or more intensity levels for performing one or more supra-threshold hearing  
7 measurements, and

8 c) means for selecting delivery of said acoustic test stimuli through said audio

9 transducer in at least two frequency ranges for performing hearing evaluation in at least two  
10 frequency ranges.

1 38. The hand held device of claim 37, wherein said device is configured for  
2 operation by said test subject.

1 39. The hand held device of claim 37, wherein said device is configured for  
2 operation by a test operator assisting said test subject

1 40. The hand held device of claim 37, including means for performing said hearing  
2 evaluation in an unaided condition in which said test subject is not wearing a hearing aid.

1 41. The hand held device of claim 37, including means for performing said hearing  
2 evaluation in an aided condition in which said test subject is wearing a hearing aid.

1 42. The hand held device of claim 41, including means for performing said hearing  
2 evaluation in said aided condition to verify functionality of said hearing aid worn by said test  
3 subject.

1 43. The hand held device of claim 41, including means for performing said hearing  
2 evaluation in said aided condition to adjust at least one parameter of said hearing aid.

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1           **44.**    The hand held device of claim 37, further comprising means for delivering at  
2   least one of said acoustic test stimuli within the soft level listening range of normal hearing  
3   individuals.

1           **45.**    The hand held device of claim 44, wherein said soft level listening range is  
2   between 20 and 40 dB HL.

1           **46.**    The hand held device of claim 37, further comprising means for delivering at  
2   least one of said acoustic test stimuli within the comfortable level listening range of normal  
3   hearing individuals.

1           **47.**    The hand-held device of claim 46, wherein said comfortable level listening range  
2   is between 45 and 65 dB HL.

1           **48.**    The hand held device of claim 37, further comprising a contactless position  
2   sensor system for measuring the position of said device with respect to the head or part thereof  
3   of interest of said test subject.

1           **49.**    The hand held device of claim 48, further including means for automatically  
2   adjusting the characteristics of said acoustic test stimuli, including onset, amplitude and



3 frequency, in response to position measurements performed by said contactless position sensor  
4 system.

1 50. The hand held device of claim 48, wherein said contactless position sensor  
2 system comprises at least one ultrasonic transducer.

1 51. The hand-held device of claim 48, wherein said contactless position sensor  
2 system comprises means for automatically determining if the device is within an operable  
3 distance and orientation with respect to said head or part thereof of interest of said test subject.

1 52. The hand held device of claim 48, wherein said contactless position sensor  
2 system comprises means for computing the distance between the device and said head or part  
3 thereof of interest of said test subject based on the latency period between a transmitted signal  
4 emitted by an ultrasonic transmitting transducer and reflected signal received by an ultrasonic  
5 receiving transducer.

1 53. The hand held device of claim 37, further comprising means to select from at  
2 least two types of said acoustic test stimuli including speech, noise and tone types.

1 54. The hand held device of claim 37, further comprising means to select said  
2 acoustic test stimuli in at least two frequency ranges.

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1        **55.**     The hand held device of claim **37**, further comprising at least one switch for  
2     selection of said acoustic test stimuli.

1        **56.**     The hand held device of claim **37**, further comprising interface means for  
2     connecting a remote instrument for remotely operating said hand held device.

1        **57.**     The hand held device of claim **56**, wherein said remote instrument comprises a  
2     computer.

1        **58.**     The hand held device of claim **56**, wherein said interface means comprise the  
2     Internet.

1        **59.**     The hand held device of claim **56**, wherein said interface means comprise an  
2     electrical cable.

1        **60.**     The hand held device of claim **56**, wherein said interface means comprises a  
2     wireless link including any of infrared, radio frequency, electromagnetic, sound, or ultrasound.

1        **61.**     The hand held device of claim **56**, further comprising response registration  
2     means for registering test responses by said test subject and relaying said test responses to said

3 remote instrument.

1       **62.**     The hand device of claim **61**, wherein said response registration means comprise  
2 at least one key.

1       **63.**     The hand held device of claim **37**, further comprising visual status display  
2 means, including an liquid crystal display (LCD) and light emitting diode (LED).

1       **64.**     The hand held device of claim **37**, further comprising a controller.

1       **65.**     The hand held device of claim **37**, further comprising memory for storage of  
2 data representative of acoustic test stimuli.

1       **66.**     The hand held device of claim **37**, further comprising a microphone.

1       **67.**     The hand held device of claim **66**, wherein said microphone provides means for  
2 measuring ambient background noise, for self testing, or for self calibration of said device.

1       **68.**     The hand held device of claim **41**, further comprising wireless remote control  
2 means for controlling or adjusting at least one parameter of said hearing aid worn by said test  
3 subject.

1        69.     The hand held device of claim 68, wherein said wireless remote control means  
2        comprise a magnet.

1        ~~70.~~ A system for performing hearing evaluation of a test subject comprising:

a) a hand held device containing an audio transducer within, said hand held device being positioned within the direct sound field range of said audio transducer and positioned in a contactless manner with respect to a test ear of said test subject,

b) an auxiliary instrument operably connected to said hand held device for remotely controlling the operation of said hand held device, and

7 c) means for selecting the delivery of acoustic test stimuli through said audio  
8 transducer at two or more intensity levels and at two or more frequency ranges.

1           **71.**     The system of claim 70, wherein said hand held device is independently operable  
2     as a hearing evaluator when detached from said auxiliary instrument.

72. The system of claim 70, wherein said hand held device further comprises a contactless position sensor system for measuring the position of said hand held device with respect to the head or part thereof of interest of said test subject.

1        **73.**    The system of claim 72, including means for automatically adjusting the

2 characteristics of said acoustic test stimuli, including onset, amplitude and frequency, in response  
3 to position measurements performed by said position sensor system.

1 74. The system of claim 70, including means for performing said hearing evaluation  
2 in an unaided condition in which said test subject is not wearing a hearing aid.

1 75. The system of claim 70, including means for performing said hearing evaluation  
2 in an aided condition in which said test subject is wearing a hearing aid.

1 76. The system of claim 75, including means for performing said hearing evaluation  
2 in said aided condition to verify functionality of said hearing aid.

1 77. The system of claim 75, including means for performing said hearing evaluation  
2 in said aided condition to adjust at least one parameter of said hearing aid.

1 78. The system of claim 70, including means for programming the function or  
2 operation of said hand-held device with said auxiliary instrument according to the needs of said  
3 test subject.

1 79. The system of claim 70, wherein said hand held device further comprises  
2 response registration means for registering test responses by said test subject and relaying said

3 test responses to said auxiliary instrument.

1 80. The system of claim 79, wherein said response registration means comprise at  
2 least one key.

1 81. The system of claim 70, wherein said auxiliary instrument is a computer.

1 82. The system of claim 70, including means for remotely connecting said auxiliary  
2 instrument to said hand held device through the Internet.

1 83. The system of claim 70, wherein said auxiliary instrument is an audiometer.

1 84. A method of evaluating a test subject's hearing with a device containing a  
2 contactless position sensor system and an audio transducer, said method comprising the steps  
3 of:

4 a) measuring the position of said subject's head or part thereof of interest relative  
5 to said device with said position sensor system when said device is oriented to face said  
6 subject's head or part thereof of interest;

7 b) automatically determining any of the characteristics of acoustic test stimuli from  
8 said audio transducer, including onset, amplitude and frequency thereof, according to the  
9 measurement performed by said position sensor system; and

10 c) delivering said acoustic test stimuli to said test subject while said device is  
11 oriented toward said subject's head or part thereof of interest.

1 85. The method of claim 84, including the step of orienting said audio transducer  
2 at approximately 0° degree incidence and within a distance range of 30-60cm with respect to  
3 the forehead of said test subject, while performing said step of delivering acoustic test stimuli.

1 86. The method of claim 84, including the step of orienting said audio transducer  
2 at approximately 0° - 45° degree incidence range and within a distance range of 2-10 cm with  
3 respect to a test ear of said test subject while performing said step of delivering acoustic test  
4 stimuli, for monaural hearing evaluations.

1 87. The method of claim 84, including delivering said acoustic test stimuli in an  
2 unaided condition in which said test subject is not wearing a hearing aid.

1 88. The method of claim 84, including delivering said acoustic test stimuli in an  
2 aided condition in which said test subject is wearing a hearing aid.

1 89. The method of claim 88, including delivering said acoustic test stimuli in said  
2 aided condition to verify the functionality of said hearing aid.

1        **90**        The method of claim **88**, including delivering said acoustic test stimuli in said  
2        aided condition to adjust at least one parameter of said hearing aid.

1           **91.**   The method of claim **84**, wherein said device is hand held by said test subject  
2   during said hearing evaluation.

1           **92.**     The method of claim **84**, wherein said device is worn as a wrist watch by said  
2     test subject during said hearing evaluation.

1           **93.**     The method of claim **84**, wherein said device is configured to be held by a test  
2     operator assisting said subject during said hearing evaluation.

1           **94.**     The method of claim **84**, including connecting a remote instrument to said  
2     device via an interface to remotely control said device during said hearing evaluation.

1           **95.**     The method of claim **94**, including connecting said remote instrument to said  
2     device via the Internet.

1        96.    The method of claim 94, wherein said remote instrument is a computer.

1           **97.**    The method of claim 94, wherein said remote instrument is an audiometer.



2        **98.**    A method of hearing evaluation for an individual holding a hand held device  
3        containing an audio transducer for delivering acoustic test stimuli in a contactless manner and  
4        within the direct sound field range of said audio transducer with respect to a test ear of said  
5        individual, said method comprising the steps of:

- 6                a)    delivering at least two levels of said acoustic test stimuli to said test ear of the  
7        individual, and  
8                b)    delivering said acoustic test stimuli in at least two frequency ranges.

1                **99.**    The method of claim **98**, including orienting said audio transducer at  
2        approximately 0° degree incidence and within a distance range of 30-60cm with respect to the  
3        forehead of said individual.

1                **100.**    The method of claim **98**, including orienting said audio transducer at  
2        approximately 0° - 45° degree incidence range and within a distance range of 2-10 cm with  
3        respect to said test ear, for monaural hearing evaluations.

1                **101.**    The method of claim **98**, including performing said hearing evaluation in an  
2        unaided condition in which said individual is not wearing a hearing aid.

1                **102.**    The method of claim **98**, including performing said hearing evaluation in an  
2        aided condition in which said individual is wearing a hearing aid.

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1           **103.**   The method of claim **102**, including performing said hearing evaluation in said  
2 aided condition to verify the functionality of said hearing aid.

1           **104.**   The method of claim **102**, including performing said hearing evaluation in said  
2 aided condition to adjust at least one parameter of said hearing aid.

1           **105.**   The method of claim **98**, in which a test operator holds said device while  
2 assisting said individual in said hearing evaluation.

1           **106.**   The method of claim **98**, including connecting a remote instrument to said  
2 device via an interface to remotely control said device during said hearing evaluation.

1           **107.**   The method of claim **106**, including connecting said remote instrument to said  
2 device via the Internet.

1           **108.**   The method of claim **106**, wherein said remote instrument is a computer.

1           **109.**   The method of claim **106**, wherein said remote instrument is an audiometer.